

Avicenna's Great Contribution to Mathematics

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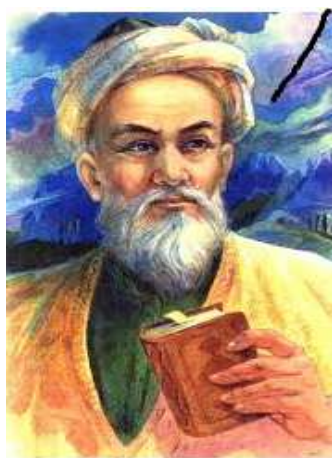
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ABSTRACT

This article is dedicated to the 1040th anniversary of the birth of the great scientist of Central Asia named Avicenna (Abu Ali Ibn Sina). The authors begin information about how Avicenna received knowledge from his mentors in childhood and clarify mathematical materials issued from books called "The Book of Knowledge" and "The Book of Healing", which are of great importance among the scientific works of the scientist. These works describe the tasks of squaring numbers and their division, as well as information regarding elementary geometry, which must be given in sequential order. Along with this, it is said that Avicenna was also engaged in the proof of the fifth postulate of Euclid.

KEYWORDS: arithmetic, geometry, straight line, plane, perpendicular, Euclidean geometry, book of knowledge, book of healing, proportion, postulate, axiom, square, cube, remainder



Avicenna was born on August 16, 980 in the village of Afshona, near Bukhara. Avicenna's real name Hussein. As it was known from history, his father, Abdullah was a noble man of his time. After the Abdullah's family moved to Bukhara in 985, Avicenna began to study the concept of mathematics (arithmetic, geometry, algebra) with his first mentor Mahmoud Massakh. So far there hasn't been clear information about how long the boy took lessons from Mahmoud and how far he advanced in mathematics.

During the childhood and adolescence of Hussein, Bukhara was one of the most important cultural centers of the East. There were schools, libraries, hospitals at that time. Many officials, lawyers, scientists, philosophers, architects and doctors lived in the city.

An important stage in the Avicenna's teachings came when the philosopher Abu Abdallah Natili arrived in Bukhara. Avicenna's father took advantage of this circumstance, invited a visitor to his house so that he could study philosophy, logic, mathematics and other sciences with his son. Under his leadership, Avicenna worked on a number of the most important books "Eisagogue" on logic, "Elements of Geometry" by Euclid and "Almagest" by Ptolemy on mathematics. The boy soon surpassed his mentor. Whatever questions Natili posed, the student penetrated the essence

much better than the mentor himself. In geometry and astronomy, Natili was insufficiently prepared. He taught the boy the first few theorems of Euclid, and the rest of the theorems must be comprehended by the boy himself. Astronomy classes were conducted according to Ptolemy's "Almagest". After the introductory part of this work was explained, and it was necessary to learn the formulas. Natili made the student learn instructions and the theorems independently in the same. Then the boy showed him the ready-made results of his work. Continuing independently study geometry according to Euclid and astronomy according to Ptolemy, the boy was able to master the material well and understand the most difficult questions of these sciences. To the credit of the teacher, it should be noted that he was able to assess the abilities of his student and was sick with his soul for his future. Therefore, Natili convinced Father Hussein not to interrupt his son's teachings in any way.

Avicenna was only 15 or 16 years old when he began to study independently, quickly mastering the achievements of all the sciences known then, by the age of 17-18 Ibn Sina had already developed as a fully mature scientist. Among other facts, it was evidenced by his correspondence with Abu Raikhan Beruni in 997.

In the scientific works of Avicenna "The Book of Knowledge", "The Book of Healing", opinions related to mathematics are given.

I. "The Book of Knowledge" is the greatest work of 1924-1937 by the great scientist of Central Asia Ibn Sina. This work comprises parts of philosophy, logic, physics and mathematics. According to the recollections of Avicenna's student Abu Ubaydo Juzjan, parts of the mathematics of the book "The Book of Knowledge" were lost.

This part of mathematics was restored by Juzdzhana from treatises written by Avicenna on the basis of geometry and astronomy.

The part of mathematics given in the book "The Book of Knowledge" was devoted to geometry and consists of 12 sections. Here we can see that the relative positions of straight lines in space and plane are stated. Along with the concepts with the given definitions, he skillfully used the proof of the theorem, constantly compared them with the methods of proofs of Euclid. These materials were based on the book "Inception" and were given data in school geometry courses. For example, in this section, the statement is considered, if two lines intersect on a plane, and the third line falls perpendicularly to the point of intersection of these lines, then this third line is perpendicular to any line drawn through the point of intersection on this plane.

Therefore, the materials in this section can be fully used by students studying the basics of geometry.

The second part of mathematics of the book "The Book of Knowledge" is devoted to arithmetic and consists of seven sections. The first section describes the types and general properties of numbers. Here are given the divisions of numbers into even and odd numbers and their properties. The second section deals with even numbers. It describes about even-even numbers, about even-odd and about the properties of these numbers. The third section talks about odd numbers and the fact that they come in three forms, as well as their properties. They are composed of prime, compound and reciprocal prime numbers. The fourth section talks about "imperfect" and "perfect" numbers. It describes the characteristics of division and the properties of numbers into three types based on the equality or inequality of the sum of divisions of these numbers. The fifth section talks about "excess" and "insufficient" relationships and their properties. The sixth section is devoted to "complex" relationships and statements over numerical examples. The seventh section describes the types and properties of proportions.

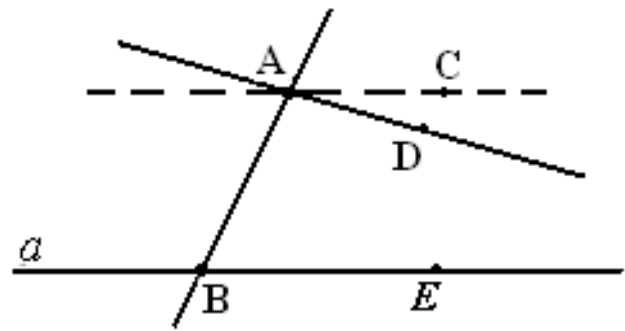
II. Ibn Sina's book "The Book of Healing" is one of the valuable works in his life. This work is similar to the book "The Book of Knowledge" and is divided into large books called "Logic", "Physics", "Mathematics" and "Metaphysics". The book "Mathematics" of his works consists of the sections "Abbreviated Euclid" or the foundations of geometry, "Abbreviated Almagest" and "Arithmetic". The "Abridged Euclid" section of this book is divided into 15 sections, and the information on the basics of geometry is presented in a similarity to the book "Inception" of Euclid. In this part, the concepts of geometric figures in plane and space are given and their properties are considered. It is also worth noting here that these geometrical materials are not a direct translation of the book "Beginning", because the required materials of mathematics in kration, expressed by their opinion, enriched this part with accurate information. For example, besides the 5 postulates, Euclid gives the following postulates:

VI. Two straight lines contain no space.

VII. A straight line does not coincide in its direction with two straight lines at the same time.

Here you can see that the V postulate and the 9-axiom of Euclid are the same. At the same time, in this book, as well as in "The Book of Knowledge", scientific researchers were done to prove the V postulate of Euclid in the form of a theorem. The V postulate of Euclid is more complicated than the other four postulates, i.e. this postulate is presented in the following form: "If a straight line falling on two straight lines forms internal and on one side angles, in total less than two straight lines, then these two extended straight lines will meet indefinitely on the side where this sum is less than two straight lines." By virtue of this postulate, at most one straight line passing through A and not intersecting a can be drawn through point A outside the straight line a in the plane defined by point A and straight line a (in Fig. 1, the angles ABE and BAD are in total less than two straight lines and AD and BE intersect, the angles BAC and ABE are equal to two straight lines and the lines AC and BE are parallel).

Here, this postulate was treated with suspicion, because people experienced the correctness of other Euclid's postulates on a daily basis in practice.



Picture 1 Euclid's V postulate

Avicenna proved the fifth postulate by accepting without evidence the statement that "Two lines located on the same plane and not intersecting with each other are located from each other at the same distance." But this statement is equivalent to the fifth postulate.

The fifth postulate of Euclid plays a significant role in geometry. After Euclid Notable scientists of the world have been conducting research on the way to prove this postulate for several centuries. As a result of this, by the arrival of the 19th century, non-Euclidean geometry named after Lobachevsky appeared.

The "Arithmetic" part of the "Book of Healing" provides information on the methods of operations with numbers. Here are the rules for checking the validity of methods for raising numbers using the number 9 to the values of a square and a cube. After that, Ibn Sino designated the Indian method test using the number 9 squares with the following rules:

- If a digit is divided by 9, and the remainder is 1 or 8, then the square of this number is divided by 9, the remainder is 1.
- If a digit is divisible by 9 and the remainder is 2 or 7, then the square of that number is divided by 9 and the remainder is always 4.
- If a digit is divided by 9, and the remainder is 4 or 5, then the square of this number is divided by 9, the remainder is 7.
- If a digit is divided by 9, and the remainder is 3 or 6, then the square of this number is divided by 9, and the remainder is 9.

As we know, in his era, Avicenna, along with the spread of the mathematical work of Euclid and Ptolemy to Central Asia, developed and enriched them, and also had the talent to masterfully use them at the right time. Therefore, in awakening students' interest in mathematics and in educating them with the right people in society, it is important to familiarize them with the contribution of our great scientists to science.

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